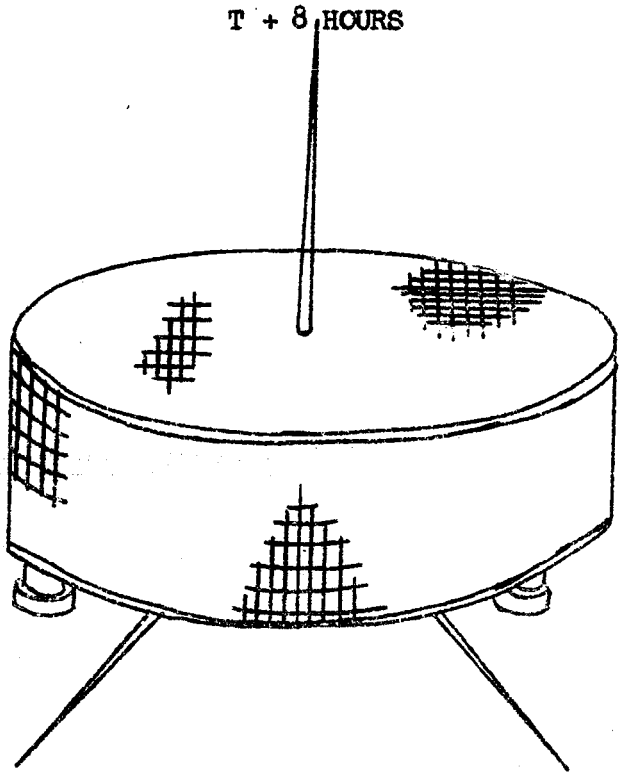
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

GODDARD SPACE FLIGHT CENTER

DELTA 5

FLIGHT FLASH REPORT

T + 8 HOURS



TIROS 3

12 July 1961

GODDARD SPACE FLIGHT CENTER
FIELD PROJECTS BRANCH
ATLANTIC MISSILE RANGE

DELTA 5 FLIGHT FLASH REPORT

July 12, 1961

1.0 SUMMARY

Delta 5 (Tiros A-3) vehicles 286/2014/3014, was launched 12 July 1961 at 0525 EST. First and second stage performance was nominal or better. Third stage burning time was nominal with apparent above nominal performance. The spacecraft was placed in orbit and is reported to be operating satisfactorily.

2.0 LAUNCH PREPARATIONS

2.1 F-6 Day Test

The following is a listing of discrepancies from the F-6 Day Acceptance Test which was conducted 30 June 1961.

A drop in the second stage controls battery was noted on telemetry at about SECO + 200 seconds. This drop appeared as if a load had been applied, however, no known load could be detected as occurring at this time. It was thought to be possibly a result of the programmer heater cycling. The voltage drop was small and telemetry resolution was of such a small magnitude that it was not fully explained.

The second stage roll dead zone was measured to be 1.25°. The specification for this is $1.5^{\circ} \pm .25^{\circ}$. Since this was on the extreme low side of the specification, it was rechecked and readjusted to put it in the center of the specification.

The second stage static inverter read high on telemetry. The voltage read 15.5 volts and the maximum spec value is 15.3 volts. DAC thought it was the telemetry calibration. A special check was requested where the output of the inverter and telemetry were measured simultaneously and it was confirmed that the inverter voltage was out of spec. The inverter was replaced.

The Stage I inverter voltage increased 3% during the internal run. The measurement was still in specification and was determined to be a result of a high battery voltage charge due to loading versus use time. No action was required.

The deviation of the second stage telemetry transmitter center frequency was 90 Kc instead of the desired 70 Kc, and the repetition rate of 924 cps was in excess of the allowable range limit of 900 cps. The deviation was adjusted and the repetition rate was rechecked and found to be acceptable.

MECO was sent later than required in the countdown. This was determined to be a personnel error.

The second stage control power supply malfunctioned at the completion of the test. The problem was found to be caused by a failure in the cooling circuit which is interlocked with the power supply.

2.2 F-3 Day Test

The F-3 Day All Systems Test was conducted on 6 July 1961. The following problems were encountered:

The first stage programmer failed to start when turned on the first time for the external run. A broken wire was found in the "T" cable causing intermittent contact. The "T" cable was replaced.

On 6 July 1961 the second stage telemetry transmitter was removed because of a high PFR as experienced during the F-6 Day check. It was determined that the recheck of this measurement following the F-6 day test was done incorrectly and it was in fact still out of specification. Transmitter S/N 338 from second stage 2016 was installed.

During F-3 day checks, a destruct signal sent by Range Safety for an adjacent test was received by Delta range safety receivers. The radiation was 2 mc off Delta center frequency. The Delta antenna gain is 100 db down at this frequency and would have to be illuminated with 100,000 microvolts to receive the necessary 1 microvolt at the receiver. Transmitting and receiving antennas were oriented such that necessary power was received.

Upon completion of the internal run, as the second stage guidance power was switched to external, guidance plate power was lost. Troubleshooting revealed a diode shorted on the guidance time delay hold-in relay. This diode and another one, which seemed to open when warm, were replaced and the system then operated normally.

The main supply valve on the primary pneumatic console was changed because of leakage. Leak checks of the new valve indicated no leakage.

Examination of engine records showed actuation times for the main lox valve to be erratic from the time of signal to full actuation. Switch to switch time of the valve itself was normal, which indicated that the problem was in the 4-way valve. This valve was changed and requalified. Additional checks on actuation times were observed during the T-1 day engine check sequences.

2.3 F-1 Day Test

F-1 day countdown began at 0915 EST, T-465 minutes on 10 July 1961. Engine checks were run with only one discrepancy. During the observer cutoff sequence, the firex water and engine section deluge came on at MECO. The reason was determined to be that the firex enable switch on the facility control console was inadvertently left in the enable position. There was no damage caused by the short duration water deluge. Spacecraft checks were completed with no problems. Electrical systems checks were released at 1115 EST. Following the internal run, a review of the data showed the first stage yaw gyro drift rate was approximately 70 degrees per hour. Since this gyro had a past history of erratic drift characteristics, the decision was made to replace the gyro. The time required to change and requalify the gyro, and a mission ground station antenna problem at Wallops Island made meeting the launch time marginal, consequently, the F-1 day countdown was delayed for 24 hours.

The second F-1 day countdown began at 0755 EST on 11 July 1961. Since the engine checks were accomplished on the previous day, they were omitted from the F-1 day checks on this date, and spacecraft checks and electrical systems checks were started at 0800 EST. Spacecraft checks were completed at 0917 EST with no problems. The electrical systems checks consisted of an external run with range readout of the C band beacon and a short internal run. The instrumentation battery voltage dropped to 26.5 volts which is the lower limit of the tolerance. The battery was not replaced

but was to be closely observed on F-0 Day. Oscillations were observed on the GG lox regulator position on telemetry. The problem was determined to be in telemetry and the regulator assembly was not changed.

An unexplained small drop in battery voltage occurred just prior to SECO on the external run. A detailed record review led to the conclusion that it was the result of a change in the ground power supply.

Three pulses were observed on channels 1 and 16 of second stage telemetry at 280 seconds. A detailed record and schematic review established that it was due to guidance enable steps from the CEA tape during reset. F-1 day countdown was completed at 1138 EST on 11 July 1961.

2.4 Launch Countdown

The launch countdown began at 1955 EST on 11 July 1961. The countdown proceeded normally without problems until after fairing installation. At this time, it was found that the anti-rotation pin in the third stage spin table had sheared. The fairing was removed and the pin replaced. The instrumentation battery in the first stage was also replaced since it was still on the low limit of voltage.

During the integrity inspection in final preparations, an acceleration switch in the second stage was found to be mechanically damaged and was replaced.

The countdown proceeded normally and terminal count began as scheduled at 0450 EST on 12 July 1961. At 0453 the Range was requested to send an ARM function. The command carrier was present but no signal was received. Another ARM function was requested and received. On checking, the SRO determined that the initial function was not sent.

At 0507 it was noted that the 100% lox float switch was not functioning properly. A small amount of lox (approximately 200 lbs) was dumped, and the switch operated remotely from the blockhouse. The tank was then refilled to 100% and theswitch functioned properly on subsequent cycles.

The terminal count proceeded without holds to liftoff at 0525:06.783 EST.

3.0 TRAJECTORY

3.1 First Stage

The first stage trajectory was slightly right, with respect to nominal. The pitch plane trajectory deviated only slightly from nominal. Predicted first stage impact location indicated that MECO velocity was in excess of 300 ft/sec high and doppler data indicates 305 ft/sec high. Wind shears encountered were negligible and the effects on the trajectory were not noticeable.

The effect of BTL guidance steering was apparent in that the IP history was nominal. At MECO, the spacial location was within 1 n.m. of nominal, and the velocity vector orientation dispersions in pitch and yaw were less than .015 degrees.

3.2 Second Stage

The powered flight trajectory was slightly low and slightly right of nominal. The predicted impact location for SECO was beyond nominal BTL cutoff by about 90 n.m. Trajectory information indicates very good guidance steering operation.

4.0 SEQUENCE OF EVENTS - ALL TIMES IN SECONDS FROM LIFTOFF (NOMINALS IN PARENTHESES)

Ignition to liftoff	3.505 sec
Roll program (2-9)	2.1 to 9.1
Pitch program start (start 10, stop 140)	Nominal times
First stage guidance (start 90, stop 153)	90.2
Autopilot gain change (110)	110
Fuel float switch	---
LOX float switch	150.9
MECO (158.62)	159.1
Second stage ignition (162.62)	163.4
Second stage pitch program (start 175.02, stop 270.17)	Nominal times
Fairing jettison (182.62)	183.7
SECO (276.63)	272.2
Turnoff hydraulics (278.13)	273.7
Coast phase pitch program (start 288.62, stop 346.12)	289.1, 346.3
Fire spin rockets (718.62)	718.9
Spin rate (126 rpm)	115
Third stage ignition (720.62)	720.9
Third stage burning duration (42 sec)	42
Payload separation	Confirmed

5.0 PROPULSION

5.1 First Stage

The first stage operated at approximately nominal performance for 158.8 seconds.

No anomalies were noted in the flight data other than a gradual rise in Vernier Pc and lox pump inlet pressure during the initial 50 seconds of burning time. Further analysis is required to determine the cause of this anomaly.

The Vernier engine operated for 14 seconds after MECO. The usual stage separation characteristics were observed on the Vernier Pc trace at 4.5 seconds after MECO.

Propellant utilization was extremely good as indicated by a sharp decay just prior to MECO and is estimated to be 99.9%.

It was noted that the gas generator lox reg. position indicator gave proper indications during flight. This parameter gave erroneous indications prior to launch which necessitated a special check of the system.

Total thrust	151,470 lbs
Main engine chamber pressure	526 lbs
Vernier engine chamber pressure	360 psia
GG LOX reg. ref. pressure	508 psia
Fuel pump inlet pressure	53 psia
LOX pump inlet pressure	38 psia
Turbopump speed	5,800 rpm
Turbine inlet temperature	1,200 degrees
Propellant remaining at MECO	100 lbs of fuel
PU at MECO	99.9 percent

5.2 Second Stage

Second stage performance was nominal and SECO was commanded by BTL at 109.3 seconds of burning time.

Engine parameters all appear to be near nominal with a resultant thrust of 7530 lbs.

Helium heat generator ignition was initiated by timer command at second stage signal +10.2 seconds. Sufficient gas was available for coasting flight control and at loss of telemetry the sphere pressure was approximately 200 psia.

HPS-2 operation appeared to have an unusual cycling rate of 2 to 4 cps increasing to 6 cps at +60 seconds in the region of max "Q".

Engine chamber pressure	204 psia average
Helium tank pressure	1,625 psia at second stage start
Helium reg. outlet pressure	353 psia
Fuel injector pressure	320 psia
Oxidizer jacket outlet pressure	270 psia
Oxidizer tank ullage pressure	350 psia
Fuel tank top pressure	345 psia
Burning time	109.3 seconds

6.0 GUIDANCE AND CONTROL

6.1 First Stage

The first stage control system performed satisfactorily during the boost phase. Max "Q" effects were within the expected range and liftoff transients were negligible. Initial BTL steering commands at T+90 seconds were relatively minor, indicating a reasonably good trajectory. The uncaged stage II gyro indicated an unusually low stage I roll gyro drift rate. MECO induced only minor control disturbances.

Immediately following MECO and concurrent with the transfer of attitude control to the Vernier engines, a divergent oscillation at approximately 6 cy/sec developed in the pitch plane. This instability is verified by the pitch attitude and rate gyro telemetry channel as well as the main engine position data. Stage II separation occurred before the magnitude and rate of this oscillation became disastrous. At separation the rates were at or near zero and the attitude errors were less than 1.0 degree. The cause of instability in the pitch plane vernier control is not yet known. Vernier Pc appears normal.

6.2 Second Stage

The second stage guidance and control systems performed satisfactorily. All programmer functions appear on time. Attitude error during both powered and coast flight were negligible. Stage I/II separation transients were small and easily corrected. BTL steering orders were rather small indicating good MIG gyro stability and proper pitch program input. Fairing separation was on time and caused negligible attitude disturbances. All battery and inverter voltages were steady and at the proper levels.

6.3 Coast Phase

Coast control was satisfactory although a regular limit cycle was not established in pitch/yaw or roll attitude channels. This is an unexplained, but not unexpected phenomenon. A pitch (up moment) of approximately 1 percent of the control movement was evident from SECO. Dead zone limits were not exceeded at any time during the coast phase.

Stage III spin-up and ignition occurred on time. Spin-up rpm appeared rather low (112 rpm actual vs 126 rpm nominal). Stage III separation caused only slight stage II attitude disturbances. At stage III separation the vehicle attitude errors were less than $1/4^{\circ}$, and rates were less than 1°/sec.

Normal coast attitude control system operation continued after the Stage III ignition/separation sequence.

7.0n GUIDANCE

All BTL signals were sent and received as planned. All steering function were normal. BTL commanded SECO approximately 4 seconds early due to above nominal velocity.

8.0 SPACECRAFT

The Tiros 3 spacecraft prelaunch checkout was accomplished without difficulty. After fairing installation it was discovered that the anti-rotation pin in the stage III spin table had been sheared. The fairing was removed and the pin was replaced. Thorough inspection revealed no other damage. Spacecraft checks were repeated after reinstallation of the fairing and were satisfactory. No positive explanation for the pin shearing could be established. Spacecraft performance throughout the countdown, liftoff and launch phase was completely satisfactory.

During the launch phase the GSFC-AMR Satellite Tracking Station tracked the 108 mc beacons.

Reports were received from Wakefield, England, confirming spacecraft third stage separation at 1047.41Z and spacecraft despin at 1052.20Z. The spin rate after despin was reported to be approximately 9 rpm.

Woomera acquired the satellite beacons at 1126A and confirmed despin. The PMR station acquired the satellite and attempted readout of the stored infra-red data which was gathered during launch and injection but this was unsuccessful. Readout was accomplished during passage over the Wallops Station. The Wallops Station and the RCA Princeton Station reported satisfactory operation of the IR systems, telemetry transmission, horizon scanner and successful direct camera 1 and 2 operation with excellent pictures. The measured spin rate was 9.2 rpm.

On the second pass of the satellite, Wallops Station and Princeton reported that "beautiful" pictures were obtained from the camera 2 system, and that all spacecraft systems appeared to be operating as planned.

9.0 DATA AND INSTRUMENTATION

9.1 Telemetry

A quick survey of the Range tapes (Tel 2 andTel 3). DAC tapes and NASA tapes indicated Tel 2 to be superior. It was used for all quick look records. Data was held from liftoff until T+795 sec (stage II) and was quite dropout free through spinup and a short while thereafter. Some dropouts were evident during the spinup sequence, but were more severe at other sites.

Real time data was relayed from the NASA stations and successfully told the story of the flight. Due to the noisy spinup, the spinup report was somewhat delayed, but not sufficiently to create undue concern among those awaiting its arrival.

No report was received fromWallops Island concerning its telemetry coverage. It is hoped that this does not connote lack of signal acquisition and reduction.

No report is presently available fromAMR Station 3.

Telemetry ELSSE: Telemetry ELSSE was GO at all times prior to launch, and had track fromT+14 until T+ 570 sec in the flight line and T+660 at the program site. A momentary dropout was noted at staging, a normal occurrence.

9.2 Data in General

Optics: Metric, engineering sequential, documentary and OIS cameras all ran and all should produce data. A total of 51 cameras were used.

Radars: The FPS-16, XN-1, at PAFB, was down for the launch. Due to the launch azimuth, the only two FPS-16 radars actually used were at Station 1 (1.16) and Station 3 (3.16). Station 1 was on auto beacon fromT+0 until T+802, while station 3 acquired at T+108 and lost track at T+781. Radar 1.5 skin tracked from 13 to +190 sec on automatic. Three HRT systems were used, with considerable coverage from 6 to 107 sec. This represents excellent radar coverage.

9.3 Doppler and Angle Track

During the launch phase the GSFC-AMR Satellite Tracking Station tracked the 108 mc beacons. The doppler shift in the nominal 108.00 mc beacon was measured. The frequency at liftoff was 107.997615 mc. At MECO the doppler shift indicated a slant velocity of 305.5 ft/sec greater than nominal. The indicated slant velocity

increment due to stage II powered flight was 134.2 ft/sec less than nominal. Third stage ignition was observed and tracking was maintained for 30 seconds after ignition until the spacecraft passed over the radio horizon. Using a nominal burning time of 42 seconds and extrapolating the doppler plot, a slant velocity increment due to third stage of 10.9 ft/sec less than nominal was obtained.

The last usable angular data were obtained at T+550 sec. Thereafter the tracking data were obscured by solar noise. At T+550 sec measurements indicated that the vehicle was 0.2 degrees to the right and 0.1 degree high as compared with the predicted trajectory.

10.0 PAD DAMAGE

Only normal pad damage incurred.